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UAV Mission Analysis and Planning Support System

Derek E. Henderson

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Information Technology Division
Electronics and Surveillance Research Laboratory

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ABSTRACT

DSTO provided support to an Army trial aimed at evaluating the operational concepts involved in deploying Unmanned Aerial Vehicles (UAVs) and Unattended Ground Sensors (UGSs) in northern Australia. The work described in this report was a component of the overall DSTO trial support and the purpose was to demonstrate how Information Technology could be utilised to support the operation of UAVs. To this end, a prototype Mission Analysis and Planning Support System (MAPSS) has been developed. MAPSS is a computer-based information management system for storing, managing, processing and displaying information required in the operation of UAVs.

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EXECUTIVE SUMMARY

This report describes the development of a prototype Unmanned Aerial Vehicle (UAV) Mission Analysis and Planning Support System (MAPSS). DSTO provided support to an Army trial aimed at evaluating the operational concepts of UAVs and Unattended Ground Sensors (UGSs) in the role of surveillance and reconnaissance in northern Australia. During operations UAVs will transmit large amounts of information to their ground control stations and there will be a requirement to manage and analyse this information effectively and efficiently. Additionally, large amounts of information will be required for planning UAV missions. MAPSS has been developed to demonstrate the feasibility of using a computerised information management system to meet these requirements through the provision of functions for the storage, retrieval, display, and management of the information required to support UAV operations.

MAPSS provides access to a wide range of data including structured (relational) and multimedia (text, imagery, video, audio) in the context of a map based display. Four roles for the MAPSS system are proposed: deployment planning; mission planning support; image interpretation and assessment; and real time data management and distribution. Each of the roles has its unique information needs but in general terms UAV operators will need access to: maps of the area of operations; details of airstrips within the area of operations; environmental and meteorological data; intelligence information relating to assets such as defence installations and public utilities, objects of strategic importance such as bridges and highways, and previous enemy sightings; and imagery collected by UAVs during previous missions. The MAPSS system contains the capability necessary to manage and display these types of data.

Information is accessed on the MAPSS system primarily through a map based window. Maps can be displayed and manipulated and various features plotted. Menus are provided to enable the user to plot icons on the maps indicating the existence of objects at various locations. Further information on the objects of the types described above is stored in the database and can be accessed by clicking on the icons. The information in whatever form (text, imagery, etc) will then be displayed on the screen. Alternatively, information can be found using text (string) searches of

database catalogues containing titles of documents and files, and keywords. Data used in MAPSS was acquired from the UAV trial at Tindal in the Northern Territory for the purpose of constructing a realistic, relevant demonstration system.

The system has been demonstrated to Army, was well received, and the need for such a system accepted. However if the system is to be developed further then more work needs to be done to determine the detailed user requirements which will depend upon the role and concept of operation for UAVs in the Australian Army. Also, UAVs will not operate in isolation so issues such as interoperability, compatibility, overall information requirements, information storage, and information transmission requirements, also have to be addressed.

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Derek Henderson *has been with the Australian Defence Science and Technology Organisation (DSTO) since 1991. Prior to that he was with the Ministry of Defence (MOD) UK after graduating in Electronic Systems Engineering at the Royal Military College of Science, Shrivenham, UK. During his time with the MOD he was a project management assistant managing the procurement of a submarine command system for the Royal Navy. Since joining DSTO he has undertaken studies for the Australian Department of Defence in the areas of specification, interoperability, and acquisition, of information systems. He currently works in Information Technology Division's C3I Systems Engineering Group and his research interests include C3I front end systems engineering, evolutionary acquisition, and C3I database systems.*

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ABBREVIATIONS

DCW	Digital Chart of the World
DSTO	Defence Science and Technology Organisation
GHIS	Geographic Hypermedia Information System
IBY	Intelligence Bay
ITD	Information Technology Division
IT	Information Technology
MAPSS	Mission Analysis and Planning Support System
MPS	Mission Planning System
TSD	Tactical Situation Display
UAV	Unmanned Aerial Vehicle
UGS	Unattended Ground Sensor

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1. Introduction

DSTO has provided support to the Army evaluation of Unmanned Aerial Vehicle (UAV) and Unattended Ground Sensors (UGS) under Trial Directive 8/603 [1]. Information Technology Division (ITD) of DSTO focussed on the investigation of Information Technology applications and Command and Control issues relevant to the operation of UAV and UGS systems. The purpose of this paper is to describe the work done to investigate and demonstrate the role of computerised information management systems in support of UAV command and control.

The overall objective of the trial was to evaluate the concept of deploying UAVs and UGSs in surveillance and reconnaissance roles in northern Australia. If adopted, UAVs and UGSs would form part of an electronic environment for detecting and defeating hostile incursions and protecting vital assets[2]. If the effectiveness of such a system is to be maximised then the data produced by all sensors and sources deployed in this electronic environment (not only UAV and UGS) will have to be managed in a timely fashion. This requirement may be met through the use of a computerised information management system with the capability to store, manage, process and display geographic and environmental information. This paper reports on the work done in investigating the basic requirements of such a system and developing a prototype Mission Analysis and Planning Support System (MAPSS) to demonstrate how the requirements could be implemented.

In operations it is envisaged that MAPSS would be used in conjunction with a Mission Planning System (MPS) or that MAPSS would be integrated with an MPS. The MPS would provide computerised support for setting UAV flight parameters such as flight route, height, time, and sensor settings where as the role of MAPSS would be to provide the intelligence information required to plan the flight route and the capability to analyse the data collected during the mission. UAV mission planning concepts have been investigated and a demonstration system developed[3]. The MAPSS and MPS were deliberately developed independently to enable a wider range of technologies and solutions to be evaluated.

In Section 2 of this paper the methodology used for determining the system requirements is described. Section 3 gives an overview of the Geographic Hypermedia System (GHIS), the developmental system on which MAPSS is based. Section 4 describes the basic requirements for the MAPSS system and Section 5 describes how it is implemented. Section 6 provides some comments on UAV sensor image quality, and Section 7 presents the conclusions.

2 METHODOLOGY

When developing requirements for systems broadly described as Command Support Systems it is preferable to evaluate current capabilities and interview the users to determine their requirements for new systems. The interaction with the users is particularly important if the developed systems are to meet their needs. Unfortunately in the case of UAV mission analysis and planning there are no systems currently in operation in Australia, i.e. this was an unprecedented system. Thus, in developing the prototype system it was necessary to adopt some basic requirements without input from users. The following approach was taken.

2.1 Visit to the UAV Trial

The UAV was observed, by the author, operating at RAAF Tindal in the Northern Territory during a number of missions including a Command Post Exercise. The exercise was particularly valuable since it enabled interactions between Command Post staff to be observed.

In total two and a half days were spent at the trial and the following achieved:

- the UAV was viewed in operation and the associated equipment examined. Although the quality of imagery obtained from UAV sensors was poor, and the equipment clearly not 'state of the art', it was still possible to evaluate the UAV operational concept.

- the output from UAV sensors including real-time imagery as it was transmitted from the UAV to the Command Post was viewed and assessed. A subjective judgement of the performance of the sensor and hence quality of output imagery was made. By viewing the imagery in real time it was possible to form an initial impression of the type and quantity of data that an operational MAPSS would be required to support.

- the command and control process for the UAV was observed and assessed. During the exercise it was possible to form an impression of the command and control process likely to be required in a real UAV mission, how a UAV MAPSS would fit into that concept of operations, and the level of integration with other systems that would be required.

- an Intelligence Officer was interviewed and the UAV Intelligence Bay (IBY) examined. The IBY was intended to provide tools for cutting and annotating frames of video downloaded from the UAV. Unfortunately the IBY was inoperative during most of the trial. Interviewing the Intelligence Officer provided an insight into potential image display and processing requirements (Intelligence Officers may be users of a MAPSS system).

- UAV trial personnel were interviewed and an opportunity provided to evaluate a computerised mission planner. This system comprised an on-screen map display and functionality to enable inputting of UAV mission plans for subsequent downloading to the UAV control system. It was planned to fully integrate this system with the latest generation Israeli Industries UAV systems.

2.2 Personal Experience

Many of the requirements for MAPSS were derived from personal experience gained in developing the Geographic Hypermedia Information System (GHIS). This system was developed to demonstrate various Information Technology based concepts to the defence community and may be adapted for UAV applications.

2.3 Assessment of Trial Records

Data from UAV sensors, daylight TV and infrared imagery, have been evaluated to determine their suitability for digital capture and use within an Information System (refer to Section 6). Although a direct data link from the UAV system to MAPSS was planned, to facilitate real time data transfer, time constraints meant that the trial records had to be recorded on VHS tape, and then loaded into MAPSS. Transfer and compression of imagery data was not considered.

2.4 Tailoring of GHIS to produce a prototype system

The GHIS system developed in ITD was used as the framework for the MAPSS system, thus enabling a prototype to be fielded in the short timescale available. This approach also provides sufficient scope for the evolution of more definitive and complex requirements as the roles and operational concepts for UAVs are defined and refined.

3 GEOGRAPHIC HYPERMEDIA INFORMATION SYSTEM (GHIS)

GHIS was used as the basic building framework from which the MAPSS system was developed. In this section a brief outline is given of the background, philosophy and functionality of GHIS (refer to 'A Geographic Hypermedia Information System' by G.Chase [4] for a more detailed description).

3.1 Background

Development of GHIS occurred in an evolutionary manner over the last five years or so in response to a requirement within the Defence Intelligence Community for automated information management support. Significant increases in the amount of

information to be processed by Intelligence analysts, and the limited numbers of analysts available has brought about a need for increased efficiency to handle the extra work load.

Types of information for which management tools are required include textual reports, memorandums, minutes, photographs and other forms of imagery. Other types of information requiring management include records of telephone calls, maps, and extracts from television broadcasts and video tapes.

In addition to meeting this specific user requirement for information management technology, GHIS was also developed as a vehicle for demonstrating such technology and concepts to the defence community in general.

3.2 Overview of GHIS Functions

GHIS is a computer based hypermedia information system designed for the storage, manipulation, retrieval, maintenance and display of multimedia information. A relational database is the backbone of the system, providing a means of storing structured spatial (geo-referenced) data and cataloguing multimedia data files. Structured data can be readily stored in the rows and columns of relational database tables. The multimedia data tends to be unstructured and is stored in a file-based system.

GHIS can store many types of data including the following:

- maps (raster , vector and polygon format);
- spatial data - data related to objects that can be associated with a geographic location, and hence a map location (e.g. towns, airports and ports);
- multimedia data - including textual, imagery, video and audio; and
- terrain data such as roads and political data which can be overlayed on maps.

Data can be drawn as maps with objects displayed as icons (symbols). Icons are used to indicate the existence of extra information in the underlying database. The information is retrieved by clicking on the appropriate icon. A text based tool is provided as an alternative method for searching the database. Information is found by searching on keywords and other text strings. A terrain visualisation tool is provided to allow terrain data to be displayed on maps. The tools provided allow the user to search, add, extract, edit, manipulate, delete, and view data in the database in a manner that does not require any knowledge or expertise in a database query language.

Maps may be viewed as a resizeable window. Tools are provided to allow the user to manipulate, scroll, pan, and zoom maps. Multiple map windows may be open on the screen at any given time.

An important characteristic of GHIS as far as this project is concerned is flexibility. GHIS is adaptable and can be readily tailored to operate in various configurations. The system has been designed to be versatile in that it can operate on a number of different hardware platforms including DEC, SUN and MAC. The underlying database has been designed in a manner that facilitates easy restructuring and repopulation to meet the requirements of any particular application. Similarly, the user interface can be reconfigured and in fact some reconfiguration occurs automatically to reflect changes made to the underlying database.

The features described above form the basis of the MAPSS system. GHIS also is capable of providing other functionality (such as hyperlink access to data) not required in this task and hence not described in this paper. The functionality tailored and developed for MAPSS to meet the requirements described in Section 4 are in turn described in Section 5.

4 MAPSS REQUIREMENTS.

4.1 General

UAV missions will require careful planning to optimise their use. Although less costly to operate than manned platforms, UAVs will still need information from other sources so that they can be directed to areas where there may be intruders. The intelligence officer will play a vital role in this regard, assimilating, managing, and analysing data, then making decisions, giving directions and providing input to the mission planning process.

In particular, UAV operators will need to assimilate all pertinent information prior to and during a mission. Information sources are likely to include commercial and open-source as well as sources derived from military sensors including those deployed on the UAV platform. The management problem associated with collecting large amounts of information is non trivial especially given that the UAV may be in the air collecting data for many hours at a time. There is a potential for a large repository of information to be assimilated during UAV missions. Without the appropriate information management tools and procedures in place the accumulation of too much information may cause as many uncertainties in the mission process as too little.

There is clearly a requirement for an information management tool or system which may well be met through the application of the appropriate information technology. The exact requirements are currently difficult to determine because the role of the

UAV has not been defined. The UAV is likely to operate in concert with other surveillance assets (eg helicopters & satellites) which in the near future may have digital image capture and transmission capabilities. The nature of these assets and their sensor technologies will impact on any information management requirements for UAVs.

For the purpose of developing a demonstration system three high level roles for the system were envisaged as described in the following sections; these roles assume the UAV being used in basic surveillance mode to detect intrusions.

4.2 Roles

Four high level roles are envisaged for a UAV MAPSS system:

- Deployment planning - providing the information required to enable a UAV operating site within range of the area of operations to be chosen.
- Mission planning support - providing information to support the mission planning process.
- Image interpretation and assessment - providing tools for analysing imagery collected during UAV missions.
- Real-time data management and data distribution - providing tools for managing and distributing data (including imagery) during the course of a mission.

4.2.1 Deployment Planning

In planning for the deployment of UAVs, operators will need to make informed decisions when selecting suitable UAV operating sites. A situation may be imagined where an incursion or threat is suspected in a particular area and a suitable airstrip from which to launch and recover a UAV has to be found quickly. A role for a MAPSS system could be envisaged in this scenario where access to up to date information is required.

Examples of data which may be required would include:

- Maps of the area of operations
- Airstrip information - location, length of airstrip, available facilities, condition of airstrip etc.
- Environmental and meteorological data
- Digital elevation models

Availability of the above information combined with range and endurance data (supplied by the MPS system) for the UAV would enable suitable airstrips to be selected taking into account factors such as ground station coverage and logistic support requirements.

4.2.2 Mission Planning Support

The primary role for the MAPSS system is likely to be in the area of mission planning support. Whereas the data required for programming flight and sensor parameters may be supplied through an MPS, MAPSS will be required to support the mission planning system by supplying intelligence and map data for planning the most profitable route.

It is envisaged that data required by UAV mission planners will be spatial in nature in that it will be associated with a geographic location. The data would be stored in an electronic database and would be retrievable for display at the correct position on electronic maps. Various formats of data could be stored including textual, imagery, and video clips. In the role of mission planning support, intelligence information of the following categories could be required:

- geographical data: text and imagery on the local environment including for example: vegetation; waterways; and weather conditions. This information could be provided primarily from commercial sources.

- assets: vulnerable assets in the region which might include power supply equipment, communications equipment, and defence installations. This information could be assembled from commercial or military sources. Specific data could include location of assets, imagery, and textual descriptions of the role of assets.

- other objects of strategic importance: there may be any number of these but examples include bridges and other river crossings, waterholes, and highways. Much of this data is available commercially but could be supplemented with annotations describing the strategic importance of the objects.

- target sightings: these could be sourced from previous UAV missions or from other surveillance assets, and could take the form of imagery and documented reports made by UAV operators and intelligence analysts. Whereas UAVs will supply hours of video to the ground station there may only be a few frames of important information contained within the video. The ability save a few still frames of video with annotations could be very useful.

4.2.3 Image Interpretation and Assessment

In Section 4.2.2 mention is made of the availability of imagery obtained from previous UAV missions for mission planning purposes. This capability could be enhanced by providing image processing software. Even simple image processing

techniques such as contrast, brightness, and sharpness adjustment can greatly improve the quality of an image.

A possible use of this capability would be to enable the comparison of images relating to the same feature or object taken at different times in order to determine if any changes have taken place; this would be useful for detecting the presence of enemy forces perhaps by detecting the disturbance of vegetation or the previously undetected presence of tyre tracks.

One other possible use of this functionality might be in the area of equipment identification. Images captured by the UAV would be compared with existing intelligence photographs to effect an identification.

Real-time use of this functionality might also occur as the images are transmitted back to the UAV command station and immediate image processing is undertaken to effect comparisons and identifications. Redirection of the UAV may occur as the new information is analysed.

4.2.4 Real-time Data Management and Data Distribution

In considering some basic requirements the main focus has been on the UAV operating as a stand alone system, and, due to the constraints of the trial, data has been passed from system to system by hand (i.e. tape). In the context of operational systems data will be transferred directly (most likely in digital format) between systems and in real time. The MAPSS system will therefore have to be capable of handling data in real time and allowing management, processing and analysis of data in real time to allow decision to made and actions taken during the course of a mission (as described above).

An operational MAPSS system will be required to be interoperable with other systems (e.g. AUSTACCS) so a further requirement will be the ability to route and transfer data between systems, and the ability to accept data directly from other systems.

Solutions for these requirements have not been developed in the prototype system but are mentioned here for future consideration.

5 MAPSS FUNCTIONS

5.1 Introduction

A prototype MAPSS system was built as a means of demonstrating the application of information technology to UAV mission analysis and support. The main system functions are described in this section.

A major part of the UAV Trial took place at the Tindal RAAF Base in the Northern Territory during July and August 1993. For demonstration purposes the MAPSS database was populated with data from this area to enable a demonstration to be put together which would be meaningful and relevant to Army personnel. Data used was mainly either 'open source', obtained from trial officers (photographs) or trial records (VHS tapes).

The demonstration system operates on a SUN workstation and utilises an ORACLE database. The system could, however, operate on other platforms, the ability to operate on a laptop type platform being seen as potentially beneficial for field use.

The system functions provided in MAPSS is primarily aimed at providing users with data access and management tools for storing, retrieving and displaying multimedia data collected by the UAV or obtained from other sources. Tools are provided to enable a user to search for data through special map windows or if preferred through data query windows. The user interface is designed to be intuitive and easy to use as well as reconfigurable to enable extra functionality to be added as required.

The remainder of this section describes the system functions in greater detail. Design details are omitted with the exception of the database where some design information is useful to illustrate the full functionality of the system. This section is meant to give a flavour of the capabilities of the system, **not** to be a comprehensive user manual, therefore only the most important system features are described.

5.2 The Database

5.2.1 Database Design

Data storage in MAPSS is accomplished by the provision of two separate data storage areas: the first is a conventional relational database and the second is a file system. This approach is necessary because of the wide range of data formats accommodated by the system.

Data that can be organised into a number of fields and tables (structured data) is stored in the relational database. Spatial data falls into this category because it can be organised typically in terms of fields containing name, position (latitude and longitude) and other relevant descriptive details. Some fields within the relational database tables have special significance in that code has been written to perform actions on them. For example, MAPSS recognises automatically any structured data with 'latitude' and 'longitude' fields as spatial data and plots an icon as defined in a field of name 'iconname' at an appropriate position on a map (if one is open).

Data that cannot be structured is stored in the file system. Multimedia data such as textual documents and image files fall into this category. Textual documents and image files are too large to conveniently fit within the fields of a relational database. Multimedia files can be associated with geographic locations by linking them to

spatial objects in the relational database. Special catalogues are provided for this purpose (described in Section 5.5).

5.2.2 Populating the Database

The database was populated with data relevant to the Tindal area of the Northern Territory. The data falls into the following categories:

- Maps: vector maps imported from Digital Chart of the World (DCW) and cropped to the appropriate area were used. Some investigation was done into the feasibility of using raster (scanned) maps in the system. Although technically possible, the large size (in terms of storage) meant that processing was slow so a decision was taken to defer use of this type of map until a later date. The vectors maps provide better functionality for the purpose of this system in that cartographic features can be plotted individually and scaling is more effective and simpler than with other types of maps. Typically, coastlines, roads, contours, political boundaries and rivers are examples of data that might be supplied.

- Spatial data: open source data was obtained and provided a reasonable quantity of spatial data particularly relating to objects such as population centres, airports, homesteads, farms etc. Gazetteers are available commercially on CD-ROM containing this type of data.

- Imagery: handheld imagery was taken by DSTO trial officers around the trial site providing photographs of vegetation and the environment in general. Annotations were also provided to enable the photographs to be geo-referenced to the correct location in the database along with appropriate descriptions. Photographs were digitised using a flatbed scanner and processed using Photoshop image processing software before accession into the database.

- UAV records: examples of imagery taken by the UAV sensors were obtained on VHS tape. Both still frames and short video clips containing objects of interest (for example, buildings and vehicles) were digitised before geo-referencing and accession into the database. A digital capture card and software running on a Macintosh computer were used for the digitisation procedure.

5.2.3 Data Accession

For MAPSS to be effective it is important that not only is a comprehensive database of information available to the user but also that the user can quickly and efficiently input new data in a manner that facilitates rapid retrieval of that data. In an operational situation it is likely that the user will not have the time to worry about the complexities of the database every time a document or data item has to be deposited. ITD have recognised this problem and developed software [5] which automatically scans the database for new accessions. The software then searches the appropriate documents for keywords and automatically catalogues and indexes the document so

that it can be subsequently retrieved. The software can be set by the user to scan the database at set intervals.

Automated document accession is included in MAPSS. All the user has to do is drop his file (typically a text document or image file) into the appropriate folder and will be automatically catalogued and indexed.

Extra functionality could be developed at a later date to allow, for example, the user to add some extra keywords of special significance to the catalogue, or to catalogue against other criterion such as author name and date of accession.

Input of structured data is more complicated. Ideally a full dataset pertaining to the area of operations would be loaded into the database prior to deployment and updated as required to keep the data accurate.

5.3 Map Display

The usual method for users to access information in the MAPSS system will be through the display of maps. Vector maps are used in the system because they are easier to manipulate, however the use of other types of maps is not precluded. The functions provided for the display and manipulation of maps are outlined below.

5.3.1 Cataloguing and Display

Maps are stored by dropping map files into a special map folder. In this way, a range of maps appropriate to the area of operations can be stored in the system. MAPSS then automatically recognises the files as map data which can be plotted using the menu buttons provided. Maps are plotted inside windows and multiple windows (and hence multiple maps) can be open simultaneously.

5.3.2 Feature Display

One of the benefits of vector maps is that the map data pertaining to different map features can be stored in separate files and hence plotted individually. This will provide users with the advantage of plotting less cluttered maps containing only the features of current interest. Types of map features likely to be of interest to a UAV operator may include:

- major, minor roads and tracks;
- rivers and creeks;
- railways;
- power lines; and

- lakes and reservoirs.

Additionally, UAV specific map overlays could be added as required. For example:

- UAV flight paths, current and previous; and
- Civil Aviation Authority air zones and corridors.

5.3.3 Manipulation

A number of tools are provided to enable the user to manipulate the displayed map to quickly and efficiently display the area of interest. Tools provided allow the user to:

- scroll - pan up, down, left, right;
- zoom - magnify an area of the map;
- measure distances between points on the map;
- plot objects on maps;
- clear objects from maps; and
- rescale maps.

5.4 Icon Display

Icons can be displayed on maps. Icons are symbols representing spatial objects that have data associated with them. Icon data can be added to the database prior to or during UAV missions and then plotted on a map as desired using the menu system provided. Spatial objects of interest will range widely but may include: towns and villages; farms and homesteads; defence installations; enemy sightings; etc, as discussed previously.

Having plotted some icons on a map, data pertaining to a particular icon can be accessed by clicking on the icon. Additional data for a town for example, could include population, state to which the town belongs; and its latitude and longitude. Some icons are linked directly to images which are displayed when the icon is clicked. Examples of images include photographs of vegetation in the area of interest and images captured by the UAV during operations. The stored location of spatial objects, displayed in the window, may be updated by dragging the icon to a new location.

5.5 Multimedia Display

MAPSS is designed to manage, store and display information of various multimedia formats including text, imagery, sound, and video. By handling multimedia data information can be presented to the user in it's native structure to provide for better assimilation of information content. Also, information which is stored in large files is not always amenable to storage in a relational database and therefore requires different treatment.

5.5.1 Text

Users may require access to many types of textual information. Examples could include military documentation such as intelligence reports, minutes and memorandum as well standard text documents describing items of strategic interest.

MAPSS can display textual documentation and can be linked to a commercial word processor to enable new documents to be created and existing ones edited.

5.5.2 Imagery

Imagery of various formats can be managed by MAPSS. Users can build a database of imagery relating to the area of operations. For UAV purposes a database of vegetation imagery or some satellite imagery may be of use. The ability to store and catalogue large amounts of imagery as it is acquired by the UAV is seen as the main benefit of this capability.

5.5.3 Video

A capability to store small segments of video is included more for demonstration purposes than practical use. Current technological constraints necessitate the availability of large amounts of computer memory for the storage of small video segments. Never-the-less, the power of database access and retrieval for video images is provided by the MAPSS system for demonstration purposes. New video compression techniques will soon make digital video a practical reality.

5.5.4 Audio

There may be a requirement to store audio reports and these can be handled in the same way as any other type of multimedia data. In some situations it may be convenient to annotate a report or comment on a situation with an informal vocal comment rather than typing text. Additionally, audio may be used in conjunction with other forms of multimedia as in the case of an audio track on a video segment.

5.5.4 Multimedia Searching

Potentially a very large repository of multimedia information could be assembled. Powerful tools are required to provide fast access and retrieval of information. MAPSS provides two methods for searching for multimedia information.

The first involves the icons described earlier. Icons can be linked directly to any piece of multimedia information so finding a photograph of the vegetation in a particular location is simply a matter of displaying the image icons on a map of that area and clicking on an icon. Links can be predefined or can be set interactively as associations between data items are made. Different icons or symbols can be designed to distinguish between different types of data (eg text, imagery video etc).

The second method for searching is text based. Multimedia information is indexed and the index is stored in database tables. Searches can take place on text strings and the result of the search is displayed in a window. The user can then select the document to display. This type of searching is especially useful where there is no geographic starting point (ie the information is not necessarily associated with any particular location).

6 UAV IMAGE QUALITY

The usefulness of MAPSS hinges on its ability to handle imagery. The image quality was in general found to be poor and this could cause the impact of MAPSS to be degraded. Consequently discussion on UAV image quality is warranted. How image quality could be improved is also discussed.

6.1 Still Imagery

Imagery was obtained from the UAV trial records for evaluation to determine suitability for storage in the MAPSS database. An attempt was made to choose records containing sequences with interesting features such as people, vehicles and buildings. Due to the length of UAV missions and the barren nature of the trial environment most of the tapes viewed contained very little of interest. It should be noted that the trial site was chosen as a site typical of the environment that the UAV would operate in. Also, the samples used were poor quality recordings on VHS video tapes.

When suitable frames had been selected the images were captured digitally from the VHS tapes using a Macintosh computer, video capture hardware and software. An attempt was then made to enhance the images using 'Photoshop' image processing software. Even after enhancement, however, the images were of such poor quality that they could not provide the resolution required for surveillance and reconnaissance.

Figure 1 is a typical example of a digitally captured frame of video imagery. Despite the poor quality of the image, a vehicle, and two people can be discerned.

The quality of the imagery could be improved by:

- using better sensors on the UAV platform;
- improving the operator's technique for searching - excessive 'panning' contributed to blurred images; and
- capturing imagery directly into MAPSS instead of from copies on video tape.

Despite these shortcomings the images stored in MAPSS effectively demonstrate the concept of image storage and management in an information system.

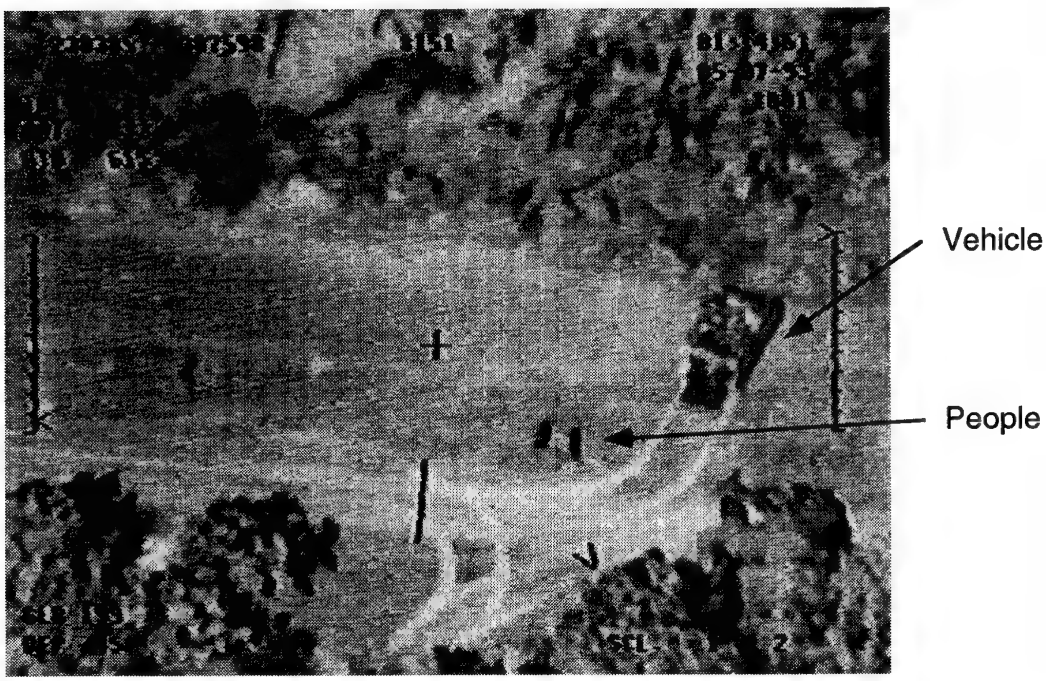

Figure 1 - Example of digitally captured imagery

6.2 Digital Video

The same procedure using different software and hardware was used to capture small segments of digital video from the VHS videotape. Again picture quality was

degraded due to the poor quality of the original imagery but it was possible to store some short segments of video in the database.

Digital video suffers from the fact that large amounts of storage are required for small segments of movie and therefore places a constraint on image size. However, compression algorithms are improving rapidly. This, coupled with the improving performance of hardware, means that a video database is feasible for the future.

7 CONCLUSIONS

1. The aim of this work was to develop a prototype (demonstration) system to demonstrate how information technology could be used to implement information management for UAVs undertaking surveillance and reconnaissance activities in northern Australia. Development of the MAPSS system has demonstrated that it is feasible to store, retrieve, display and transfer imagery and other information gathered during surveillance and reconnaissance operations in a computer based system.

2. Although the quality of imagery obtained from the UAV trial was poor, this did not hinder the development of MAPSS. The concepts involved in managing the types of information required by UAVs was demonstrated successfully despite the poor quality of the data.

3. More work is needed to determine the detailed requirements for information management in UAV operations under Australian conditions. User requirements would largely depend upon the role and concept of operations for UAVs in the Australian Army.

4. Information management aspects including interoperability and compatibility with other systems (e.g AUSTACCS), overall information requirements, information storage, and data transmission requirements, needs to be further addressed.

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3 Nelson, Dr M., "UAV Mission Planning", Task Report ESRL-XXXX-TR, December 1994.

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Appendix A

MAPSS Demonstration

After completing development of the MAPSS system a series of demonstrations was given to the task sponsors of Defence Trial 8/603 and other interested parties. In this Appendix, system functions and their implementation and usage are described in more detail than in the body of the report, user interaction is described, and screen shots from the demonstrations are provided.

A.1 MAPSS Main Window

On starting the MAPSS system the user is presented with the MAPSS main window (Figure A.1). The important features in this window are the two buttons, MAPS and SEARCH, in the top left hand corner allowing access to the **Map Window** and the **Multimedia Search Window**. At the top right hand corner of the window is the MAINTENANCE button which provides access to the systems database maintenance facilities.

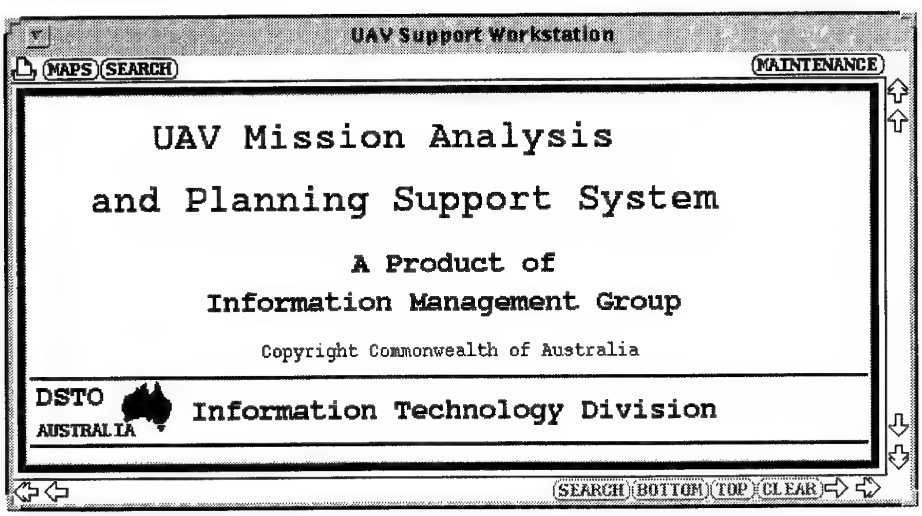


Figure A.1 - MAPSS Main Window

A.2 Map View

The map view provides access to the database within the framework of a computer generated map background. During UAV mission planning, use of the map view is likely to be the most appropriate method for accessing data since it provides information to the users within a geographic context. Functionality is accessed through buttons and menus to allow the user to select and manipulate maps, plot the spatial icons and access and edit the data underlying the icons.

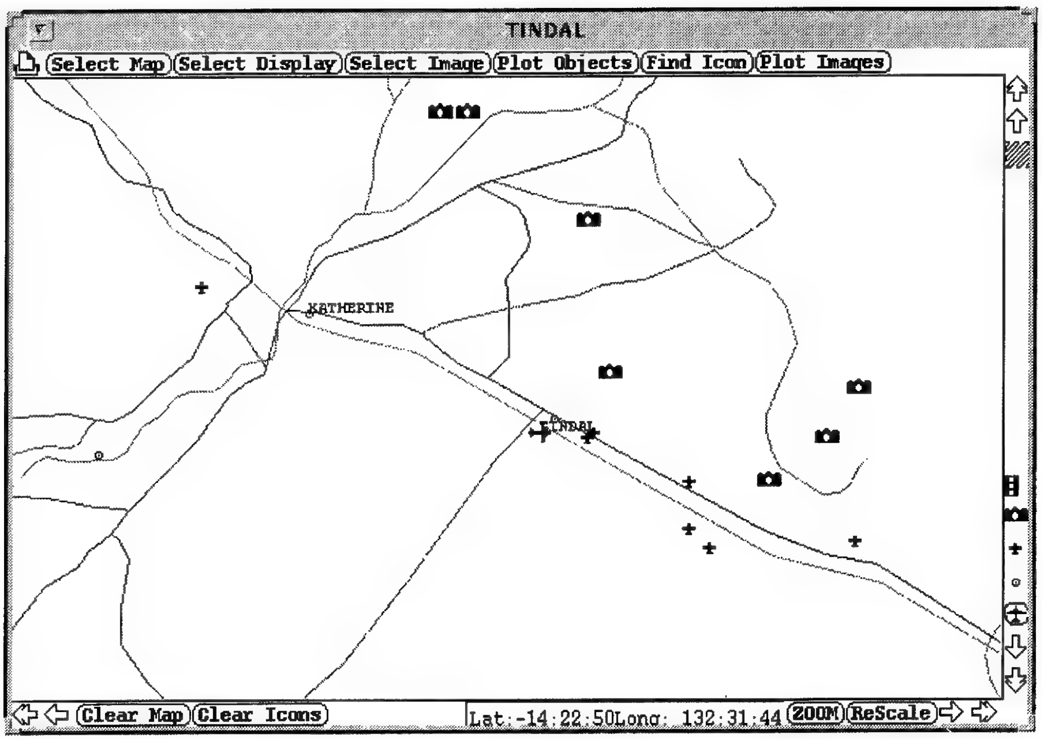


Figure A.2 - Map View

Figure A.2 is a typical screen snapshot of the map view depicting a map of the Katherine and Tindal area with main roads and rivers displayed. Also shown on the map are icons representing the Tindal airbase, Tindal and Katherine towns, handheld imagery (camera icon) and UAV generated imagery (small aircraft icon). The UAV operator may use such a map to obtain details of airstrips or to access imagery of the local vegetation.

The map window is called from a button on the MAPSS main window (see Figure A.1). Any number of map windows may exist on the screen at any given time (within

the constraints of the screen size) and so the user may view different maps simultaneously or views of the same map plotted at different scales.

The functionality associated with the map view is outlined in the following sections and methods for searching for, and accessing data is explained.

A.2.1 Map Selection

The **Select Map** menu button on the map window (Figure A.2) provides access to the map catalogue. The user can then make a choice from the available selection. New maps can be added to the catalogue as at any time simply by dropping maps (of the correct format) in the appropriate folder. When selected, the map is displayed in the **Map Window**.

A.2.2 Feature Display

An advantage of vector maps is the ability to allow the user to add features as required. The **Select Display** menu button on the map window provides the user with a choice of cartographic features such as roads, rivers, contours and creeks to plot on the currently displayed map (Figure A.3). The user simply has to select the desired features, click on the DRAW button and the features will be plotted on the currently displayed map.

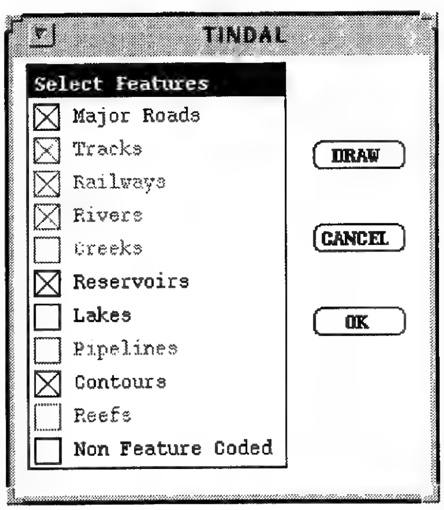


Figure A.3 - Map Feature Selection

A.2.3 Map Manipulation

The map window (Figure A.2) has the following functionality to allow the user to manipulate maps:

- **scroll bars** for panning the viewing area up, down, left and right.
- a **zoom** button for zooming in on a particular area of the map.
- a **ReScale** button allows the user to return the map to any previous size.

In addition to these basic features the cursor is tracked in latitude and longitude and may be used to measure the great circle distance between two points on the map.

A.2.4 Spatial Data Display

The most important feature of the map window is its ability to display spatial data from the relational database. Spatial data is automatically recognised by the system due to software which looks for the existence of latitude and longitude fields in the data tables. Data containing these two fields are able to be plotted on the map at the appropriate position. Additionally, a plot menu (Figure A.4) is maintained automatically providing the user with a menu of objects that can be plotted. In this way the user interface always reflects the underlying database structure and the user always has access to all the data.

Data relating to the Deployment Planning function such as airport information is accessed from this menu as is data related to the Mission Planning Support function, for example, towns, farms, and fords.

To plot some icons the user clicks the menu boxes corresponding to the object types required and then clicks on the 'OK' button. Icons will then be plotted on the currently displayed map at the correct locations.

A facility is provided to allow the user to reposition the icon to a new location by dragging it with the mouse. Alternatively icons can be repositioned by editing the latitude and longitude fields in the data window as described below.

Having plotted some icons using the **Plot Objects** Menu the user can access the data residing behind the icons by simply double-clicking on an icon. A data window (Figure A.5) will be displayed containing the data and data fields relating to the icon which was clicked.

In addition to the data the window contains buttons to allow the user to cancel the window, edit the data and to search for multimedia data.

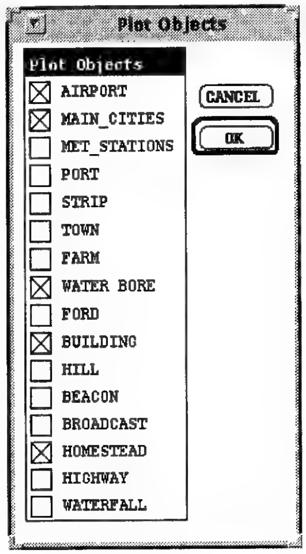


Figure A.4 - Plot Objects Menu

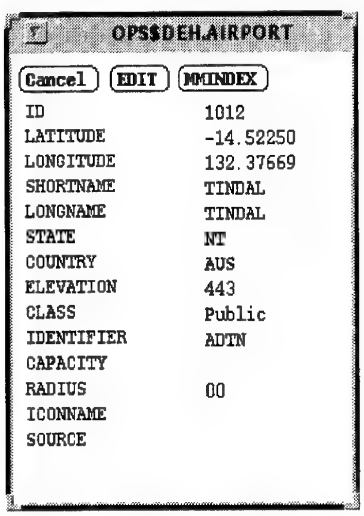


Figure A.5 - Database Object

A.2.5 Display of Spatial Imagery

MAPSS has the capability to store and display multimedia data including imagery and video. These types of data can be spatially referenced and represented iconically in the same way as the textual data described in section 5.4.4. The position of the icon on the map represents the location at which the imagery or video was taken. Icons can be repositioned on the map in the same manner as the Object Icons.

Display of imagery or video is effected simply by double-clicking on imagery or video icons in the same manner as for data icons. Selection of imagery type is via the **Plot Images** menu (Figure A.6). The menu can be reconfigured as required by the user but currently the menu provides for:

- digitised photographs captured by hand held cameras or obtained from public domain sources;
- digitised images captured from previous UAV missions;
- short digitised video clips (movies) captured from previous UAV missions.

Imagery windows have features to enable the user to pan, and magnify (zoom) the image. Video is displayed using a proprietary application invoked by the MAPSS system. The video application has the functionality to enable the usual video features such as fast forward, replay, freeze frame etc.

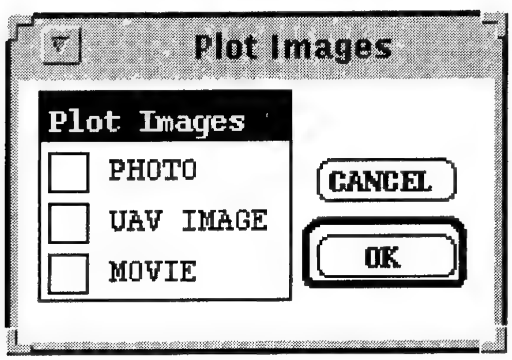
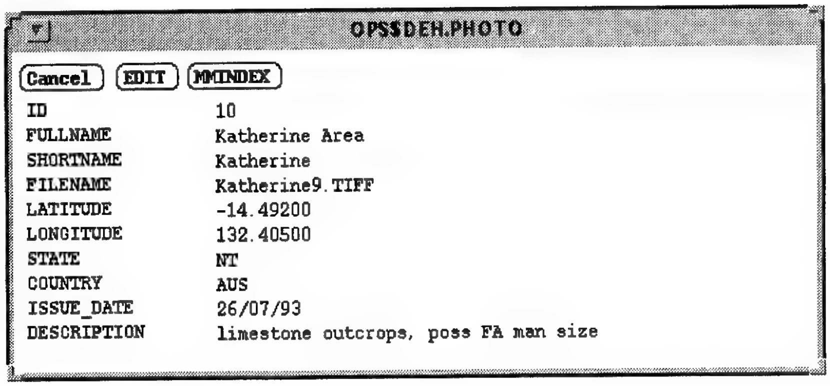


Figure A.6 - Plot Images Menu

Each image icon also has a database object associated with it to allow some comments, description or other associated information to be stored. Figure A.7 is an example of a database object associated with an image. The database object is accessed by clicking the image icon whilst simultaneously holding down the shift key.

The buttons in the window allow the user to cancel the window, edit the data and search for multimedia information.



OPS$DEH.PHOTO

Cancel EDIT MMINDEX

ID	10
FULLNAME	Katherine Area
SHORTNAME	Katherine
FILENAME	Katherine9.TIFF
LATITUDE	-14.49200
LONGITUDE	132.40500
STATE	NT
COUNTRY	AUS
ISSUE_DATE	26/07/93
DESCRIPTION	limestone outcrops, poss FA man size

Figure A.7 - Images Database Object

A.3 Multimedia Data View

In addition to the structured data associated with map icons (described in the previous sections) the system can also handle multimedia data stored in files. Documentation such intelligence reports, meteorological data, detailed information relating to environmental conditions, photographs and video clips (which may or may not be associated with a map reference) all fall into this category of data.

Management of the multimedia data is handled by a number of catalogues and indexes stored in the database; These catalogues contain references to the file names and the indexes contain a list of key words referenced to the contents of the multimedia data files. The data files are stored in a number of subdirectories which can be user defined according to some convenient categorising system such as data source, subject matter or date. This system of cataloguing and indexing enables the user to search the database for multimedia documents with information on a particular subject or category.

A multimedia search can be initiated in one of two ways: through the **MMINDEX** search button in the data object window (Figure A.5) or the **SEARCH** button in the MAPSS Main Window (Figure A.1). Use of either method will result in a multimedia search window being displayed on the screen.

Figure A.8 is a screeenshot of the results of a multimedia search on the text string 'Tindal'. The result of the search is a list of files and the catalogues in which they are stored that meet the search criteria, in this case the keyword 'Tindal'. Extensions on the file names indicate the types of multimedia data stored in the files. In the

example in Figure A.8 '.TEXT' indicates a textual document and '.TIFF' indicates an image file. The extension is in fact the name of the data format of the file and is used by the software to determine how the file will be displayed.

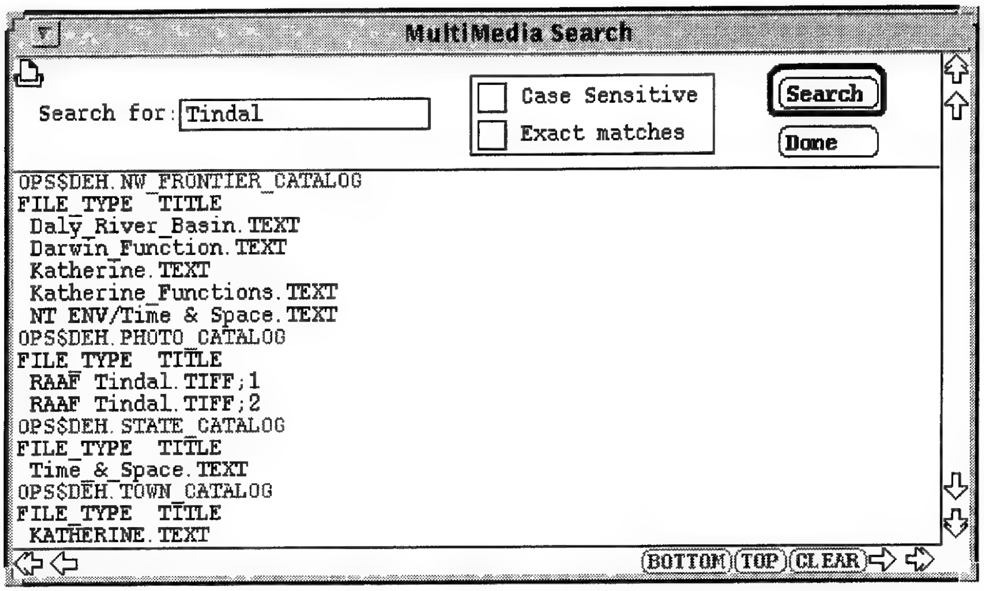


Figure A.8 - Multimedia Search View

The usual window type facilities are provided for user interaction. Scroll bars enable the user to move up and down the list of available files. Display of the required file is achieved by double-clicking on the file name in the multimedia search window. Any number of files can be displayed simultaneously. Case sensitive and exact match searches can be initiated by clicking in the appropriate boxes.

A UAV Mission Analysis and Planning Support System

Derek E. Henderson

(DSTO-TR-0162)

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19. Abstract
DSTO provided support to an Army trial aimed at evaluating the operational concepts involved in deploying Unmanned Aerial Vehicles (UAVs) and Unattended Ground Sensors (UGSs) in northern Australia. The work described in this report was a component of the overall DSTO trial support and the purpose was to demonstrate how Information Technology could be utilised to support the operation of UAVs. To this end, a prototype Mission Analysis and Planning Support System (MAPSS) has been developed. MAPSS is a computer-based information management system for storing, managing, processing and displaying information required in the operation of UAVs.